

What is food for plants?

□ Nutrients

- Essential elements used by plants in relatively large amounts for plant growth are called **macronutrients**.
- Essential elements used by plants in smaller amounts for plant growth are called **micronutrients**.

Macronutrients and Micronutrients

Element	Symbol	mg/kg	percent	Relative number of atoms
Nitrogen	N	15,000	1.5	1,000,000
Potassium	K	10,000	1.0	250,000
Calcium	Ca	5,000	0.5	125,000
Magnesium	Mg	2,000	0.2	80,000
Phosphorus	P	2,000	0.2	60,000
Sulfur	S	1,000	0.1	30,000
Chlorine	Cl	100	...	3,000
Iron	Fe	100	...	2,000
Boron	B	20	...	2,000
Manganese	Mn	50	...	1,000
Zinc	Zn	20	...	300
Copper	Cu	6	...	100
Molybdenum	Mo	0.1	...	1
Nickel	Ni	0.1	...	1

□ This division does not mean that one nutrient element is more important than another, just that they are required in different quantities and concentrations.

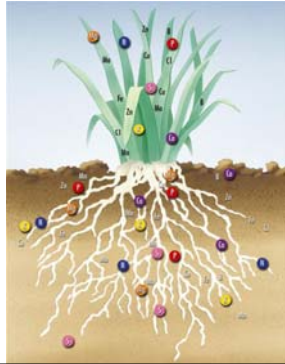
Liebig's Law of Minimum

Just as the capacity of a barrel with staves of unequal length is limited by the shortest stave, so a plant's growth is limited by the nutrient in shortest supply.



How do plants get these nutrients?

- These nutrients are dissolved in water that is attached to the soil.
- Plant roots extract the water from the soil that contains these nutrients.
- In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth.



Hydroponics

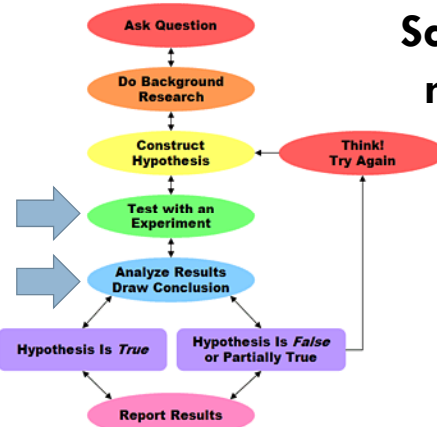
- **Hydroponics** is a method of growing plants using mineral nutrient solutions, in water, without soil.
- Almost any terrestrial plant will grow with hydroponics. Hydroponics is also a standard technique in biology research and teaching.
 - Why?



Our “experiment”

<u>Crops</u>	<u>Treatments</u>
Corn	Nitrogen (N) deficient
Soybean	Phosphorus (P) deficient
Cucumber	Potassium (K) deficient
Tomato	No deficiency
	No nutrients

Scientific method



Data collection

Quantitative

- ▣ Deals with numbers.
- ▣ Data which can be measured.
- ▣ Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, members, ages, etc.

Qualitative

- ▣ Deals with descriptions.
- ▣ Data can be observed but not measured.
- ▣ Colors, textures, smells, tastes, appearance, beauty, etc.

Symptoms of deficiency

Quantitative

- ▣ Stunted growth
 - ▣ Measure height, girth, quantify growth points, root system, biomass
- ▣ Percentage of plant displaying symptoms
 - ▣ Leaf count (healthy versus unhealthy)
- ▣ Other direct measurements
 - ▣ Tissue analysis, soil analysis, and yield

Qualitative

- ▣ Leaf discoloration
 - ▣ Yellow or white (chlorotic), brown or tan (necrotic), light green, purple, red
 - ▣ Make sure to note where on the plant or leaves you see these symptoms
- ▣ Leaf shape
 - ▣ Misshaped, curled, folded, wilted or bent

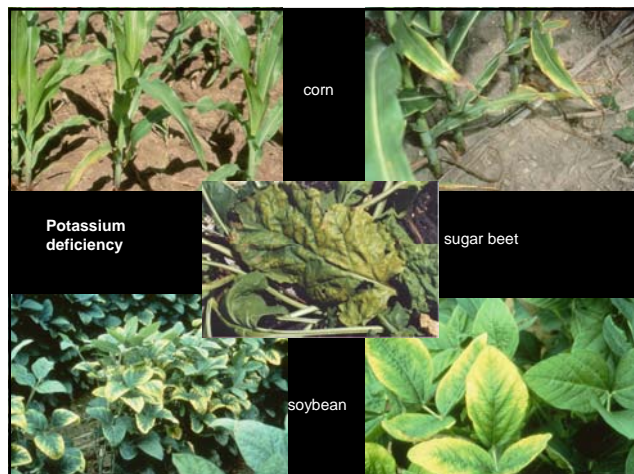


N deficiency on corn



Phosphorus deficiency on corn





Sulfur

- Mobile in soil as sulfate.
- In soil as
 - ▣ Organic matter
 - ▣ Sulfate
 - ▣ From precipitation
- In Minnesota responses in sand power plant.

